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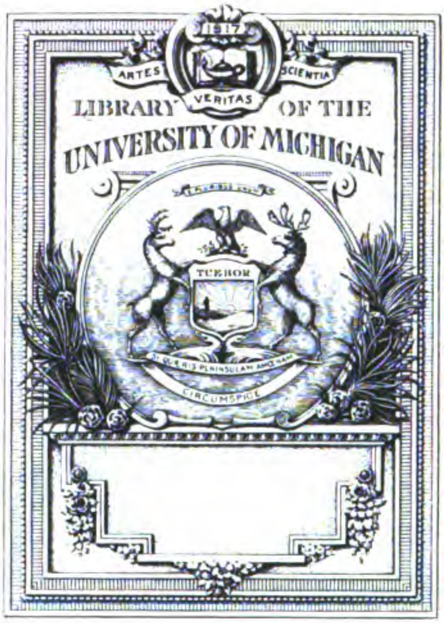
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OF THE

UNITED STATES

BY

JOHN W. POWELL

LATE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY

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PHYSIOGRAPHIC REGIONS OF THE UNITED STATES.

By J. W. Powell.

Of a country so large as the United States no adequate physiographic description can be given within the limits of a monograph of this size. The purpose here is to define the great slopes, and then a greater number of physiographic regions, which are again divided into districts, and to indicate some of their more important characteristics. Three of the regions have been selected for a somewhat more elaborate description,—one of plains, one of plateaus, and one of mountains,—thus illustrating briefly all three types. These regions are the Atlantic Plains, the Colorado Plateaus, and the Pacific Mountains, taking the eastern, a midland, and the western region.

It will be noticed that an old custom of describing great physiographic regions in units of basins has not been followed. Against that plan there are insuperable objections. Where there are large rivers, there are large basins, and such are again subdivided into ever smaller and smaller basins; and where there are oceans and gulfs, there are many small disconnected basins; so that the basin unit divides the country into very unequal parts, and fails to exhibit the association of great features that are intimately connected in physiographic history. Gradually, as the new science of physiography has grown, physiographic regions have come to be recognized; and an attempt is here made, by map and verbal description, to define the principal regions of the United States, exclusive of Alaska.

The regions here delineated are held to be natural divisions, because in every case the several parts are involved in a common history by which the present physiographic features have

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been developed. They have been characterized by the more prominent features used in the name.

In dividing the United States into a few great physiographic regions, it is not found possible always to draw the lines with exactness. Often one region blends with another, the transformation in general characteristics being marked by a general change. There are some lines of division clearly drawn by nature within narrow limits; other divisions are imperfectly marked by slow gradation from one to the other.

DRAINAGE SLOPES.

The United States may be divided into four great slopes,—the *Atlantic*, *Great Lake*, *Gulf*, and *Pacific*. All the streams of the Atlantic slope drain into that ocean by river mouths within our territory. All the streams of the Great Lake slope ultimately discharge into St. Lawrence River within our own territory. To the north another region not within our domain is drained into that river, which ultimately discharges into the Atlantic Ocean. This larger division is therefore but partly included within the United States. The Gulf slope includes all of our territory drained into the Gulf of Mexico. In popular usage, most of this is called the valley of the Mississippi, while small areas are drained into the Gulf by streams not tributary to the great river; and in the southwest there is a district drained by the Rio Grande del Norte, which heads in central Colorado, flows through New Mexico, and then turns eastward, forming the boundary line between the United States and the Republic of Mexico, until it discharges into the Gulf. Its waters only in part are caught on the soil of the United States: it is a very small part which comes from Mexico. Along the western border of this grand division the country is arid, having a rainfall of less than twenty inches annually. In this arid region there are many small streams whose waters are not carried away by ocean-feeding rivers, as the small streams are lost in the sands.

On the Pacific slope all streams that ultimately run to the sea reach the Pacific Ocean mainly within the territory of the United States; but the district drained by the Colorado River of the West reaches the Gulf of California by passing a short distance through Mexican territory. In a large part of the Pacific slope there are many small streams that discharge their waters into sands, where they are evaporated and lost from the ocean-reaching drainage; but the valleys in which they are evaporated incline toward streams draining into the Pacific Ocean.

We thus have an *Atlantic* slope, a *Great Lake* slope, a *Gulf* slope, and a *Pacific* slope; and these terms are coming into common use for the four grand divisions of the United States.

An examination of the relief map of the United States published by the general government will show that the lines of separation between these great slopes are very irregular. Everywhere along them there is an interosculation of head-water streams. Between the Atlantic slope and the Great Lake slope the divides are sometimes in mountains and sometimes in hills; between the Atlantic slope and the Gulf slope the meandering division line is in part in mountains and in part along the low peninsula of Florida; between the Gulf slope and the Great Lake slope the dividing line is an inconspicuous elevation, so low in many places that the waters may easily be diverted from one slope to another; and in late geologic time this change has often occurred, and a part of the drainage of the Great Lakes has been turned from the St. Lawrence into the Mississippi. The irregular divide between the Mississippi region and the Pacific region is sometimes mountainous, with peaks varying from eight thousand to fourteen thousand feet above the level of the sea. The Atlantic slope is a comparatively uniform declivity, relieved by plateaus, mountains, and hills that do not rise to great altitudes above the base-levels of the streams. With slight exception, the Great Lake slope is a vast plain broken into subordinate plains by terraces and hills. The Mississippi slope has the Appalachian Mountains on the east, with declivities for its streams that greatly decrease from the mountains to the river, and is relieved by plateaus, hills, and mountains with great altitudes above the rivers near the Appalachian and Rocky mountains, and has low reliefs nearer the Mississippi. On the north the line of separation from the Great Lake slope is in a single plain, but without perfect uniformity, for there are many terraces and hills. On the west the rim of the basin is in high mountains with lofty peaks, and all along its western border the reliefs are of comparatively great magnitude.

The Pacific slope is in the great Rocky Mountain region. The Stony Mountains stand on its eastern border at the north, separating it from the Missouri drainage. Here towering mountains with a wilderness of crags and peaks appear, over which the snows are mantled for many months of the year, and in whose deep gorges lie perennial snows. Then the dividing line extends between the Platte Plateaus, drained by Laramie River, and the upper extension of the Colorado Plateaus, drained by Green River. The divide is in the Park Mountains, characterized by great peaks, and extends still farther southward across the Colorado Plateaus, and down the Basin Ranges to the Mexican line. On the flanks of the Stony and Park mountains there are many volcanic peaks whose fires are now extinguished; still farther westward there are great plateaus and mesas carrying dead volcanoes on their backs; and still farther westward there are many ranges of mountains, generally extending in a northerly and southerly direction, between which lie great valleys that are often desert plains. Then we reach the Sierra Nevada at the south, and the Cascade Mountains at the north, which end the longitudinal ranges and valleys. The Cascade Mountains are mainly volcanic peaks standing on huge diastrophic plateaus, while the Sierra Nevada is a great complex diastrophic plateau carved into transverse ridges by streams that head on its eastern margin and run westward into the valley of California. The ridges between these east-and-west streams are very irregular, and decline in altitude from the east toward the west. In the Cascade Mountains the streams also have a general westward direction into the great Sound Valley; but there is a region which separates the Sound Valley from the valley of California, known as the Klamath Mountains, through which the streams heading in the southern part of the Cascade region and the northern part of the Sierra region flow to the sea without turning into the rivers of the great valleys. The Sound Valley within the United States is only a portion of a great valley which lies partly within British territory. North of Columbia River and west of Sound Valley stand the Olympic Mountains, and south of that river stand the Oregon coast ranges, sometimes called the Oregon Ranges. Thus the Pacific coast is exceedingly complex in its great topographic features.

These four grand divisions present interesting characteristics and contrasts, due chiefly to inequalities of rainfall, which produce *deserts*, *prairies*, and *forests*.

DESERTS.—Plants require great quantities of water for their nourishment. With their roots they drink the water, and through their leaves they evaporate it to the heavens. In this process a very small proportion is used by the plant, and built into its tissue. To grow a ton of hay, the grass plants must drink two or three hundred tons of water. The growth of vegetation depends very largely upon the regularity with which the roots of the plants are supplied with drink. When the rainfall is slight and periods of drought are great, vegetation is scanty; but when the rainfall is abundant, vegetation is more luxuriant. Temperature is another factor in the rate of growth. With high temperature and great rainfall, the most vigorous vegetation is produced; with low temperature and slight rainfall, more scanty vegetation is found; but if the rainfall is very small, high temperature serves rather to increase aridity and the desert condition. In the temperate zone, if the rainfall is less than ten inches annually, the desert conditions prevail; but, though the rainfall may be less than five inches annually, the desert will yet afford some classes of plants, like the agave, yucca, and cactus.

Many desert plants are covered with a kind of bark, the pores of which close in times of aridity so as to prevent their water from being evaporated. Other plants have a habit of rolling up their leaves and folding their stems in such a manner as to present the smallest surface for evaporation. Nearly all desert plants are furnished with thorns, and many with acrid juices that protect them from being devoured by animals. So the plants struggle for existence. The animals of the desert are few, though some insects and some reptiles abound; and among them many curious forms may be observed.

Deserts are beset with dunes formed of wind-blown sand. Sometimes deserts have scattered over their floors pebbles, which are the remnants of formations carried away by degradation. They are worn fragments of very hard rocks, often crystalline and of many colors. As the sand sweeps over them, the pebbles are polished, and the desert is sometimes floored with a mosaic of brilliant gems.

Prairies and Forests.—As the rainfall increases from ten to twenty inches, grasses and various other plants are multiplied, and become more and more luxuriant; and low, gnarled trees, especially cedars and pines, are developed, if they are protected from fires. As the rainfall increases from twenty to forty inches, forests increase; that is, they are extended over greater areas, and the trees themselves have a more rapid growth, and attain larger size. In such regions vigorous forests will grow, if they are protected from fire. The great prairie region of the United States is found mainly where rainfall is from twenty to forty inches, because the forests are destroyed by fire. Going from the more arid to the more humid regions, forests become more frequent and more vigorous; and especially are trees found near streams, and where the lands are hilly, broken, and stony, so that luxuriant grasses are not abundant, to furnish food for fire.

Since the prairies of the United States were settled, great changes have been wrought in the landscape. Protected from fire by the plowman's furrow, trees have sprung up everywhere; so that to-day, through all that region stretching from the Ohio across the Mississippi and across the Missouri on to the Great Plains, the forest areas are rapidly multiplying, and planted groves are common. It is thus that cultivation protects forests, and furnishes the condition for foresting lands which were prairies in their primeval state.

When man attempts to preserve large forests without protecting the ground with the plow or by other agencies, he usually fails. To save the forests, he carefully tries to prevent fires; then grass, leaves, bark, twigs, and boughs gather upon the surface of the earth from year to year, until a thick coating of inflammable material is formed. Immunity from fire thus furnishes food for fire; and when a dry season comes, an accidental spark starts a great conflagration, which spreads with the wind as only "wildfire" spreads, and the great accumulation of combustible material makes a sweeping flame which destroys everything before it. It is thus that the forests of the Northwest, which are largely held for lumber purposes, are subject to fires that destroy property on a great scale, and even destroy human life.

Where the rainfall is sufficient protection, and fires are not kindled, forests prevail. In southern latitudes and low altitudes the trees attain a greater size than in northern latitudes and high elevations; but there are some important exceptions to this general rule. In Washington, Oregon, and California, gigantic forests are found developed by humid lands that lie near the Pacific coast, while other groves of great trees stand on the slopes of the Sierras that face the great ocean. Where the moisture is more than fifty inches, and where other climatic conditions are favorable, dense forests of gigantic trees, with tangled masses of undergrowth, stretch over the land. In the great valley of California, live-oak groves abound, and the trees are gnarled and picturesque. In more arid lands, groves of low, spreading, gnarled piñons and cedars are scattered at wide intervals. In early time, before the prairie region was settled, there were found groves of low, spreading bur-oaks, that from a distance looked like orchards; and in fact they were orchards of acorns. In the humid lands, and especially in the tropic lands of Florida, the great trees are often draped with festoons of "Spanish moss," and decorated with beautiful orchids. In the valley of the Ohio, magnolias spread their blossoms as goblets of perfume. All over the Alleghany Plateaus, the Appalachian Mountains, and the Piedmont Plateaus, great tulip trees stand, with stately boles and light branches that bear most beautiful flowers. In every flood plain of the United States, sycamores with smooth trunks, broad arms, and expanding leaves, spread a sweet shade over the ground when the summer sun is fierce. By every river, creek, and brook the willows stand, and dip their delicate leaves into the murmuring waters. In the ponds and lakes of the United States, water lilies grow, and on all the hillsides roses bloom. Late in the summer the goldenrod bursts into flame along the northern border of our land; and as the weeks and months pass, the zone of gold sweeps southward until it is stopped by the Gulf.

Before the settlement of America by the Europeans, while the land was yet under the sway of savage tribes, the whole country was annually burned over, and wherever forests could be destroyed they were swept away; but when the lands were plowed, the fires were stopped; and vast regions that were prairies at that time are now forest-clad. To-day the forests of the United States are somewhat more extensive than they were at the landing of Columbus. While the prevention of fires saves some trees, the ax fells others, so that many forest regions have been transformed into fields; yet to-day fires destroy more trees than the ax.

The growth of trees depends upon rainfall, but partly also upon care. Seeing that arid lands are treeless, many observers reach the conclusion that aridity is due to the destruction of the forests. The effect is mistaken for the cause. This superstition has widely prevailed, and many of those who have not studied this subject believe that rainfall can be increased by the planting of trees. This subject has been most carefully and thoroughly investigated by scientific men, and they are not able to discover that the presence or absence of trees either increases or diminishes the rainfall; and yet this myth is told all over the land.

On the Atlantic slope primeval forests were discovered in the early settlement of the country, and a few of the valleys were prairies. Forests were mainly open, without dense undergrowth, as they were annually burned by the Indians. Since the settlement of the country, great areas have been cleared, and prairies have been brought under the plow. The forest lands that remain have been protected from fires, the undergrowth is preserved, and open forests are no longer seen. Here the forest area is smaller than at the advent of the white man, but the number of trees is nearly as great.

The Great Lake region also was mainly covered with forests when the country was settled by civilized people; but the groves were open, and the trees were comparatively low and gnarled, as they were often singed by fires. The primeval forests are nearly gone, much of the country is under the plow, but the new forests present changed characteristics. The new trees, densely crowded, compete for the light of the sun, and grow to greater heights; and the ground below is covered with dense foliage and tangled undergrowth. Here also the forest area has been reduced, but the number of standing trees is perhaps as great as in primeval times.

The greatest change has been wrought in the Mississippi slope. Its northern and central portions were mainly a prairie region, and extended to the foot of the Rocky Mountains. The few forests to the north, the greater wooded regions on the flanks of the Appalachian Mountains, and the more imposing forests on the south, protected from fires, have increased in the number of standing trees, though great fields have been cleared for agriculture. Throughout the prairie region the river-border groves have become more dense, and the trees more stately. From these groves the native forests have spread over a large aggregate of ground, and many groves and orchards have been planted. Though this prairie region is densely settled and much of it cultivated, the groves have lost their primeval character, and the vigorous trees have multiplied to an astonishing degree.

The Pacific slope presents great contrasts in its southern part, where there are extensive areas of desert. The mountains and high plateaus are everywhere covered with forests; and on the slope of the Sierras groves of giant sequoias are found, while near the coast towering redwoods appear. In western Oregon and Washington, yellow pines, redwoods, and cedars, and many other stately trees, flourish in the warm, humid lands that are supplied with moisture from the Pacific. On the Pacific slopes we have dreary deserts, prairie valleys, and gigantic forests.

THE ATLANTIC PLAINS.

A monoclinal flexure extends from the Jersey side of Hudson River near the city of New York, southwestward past Trenton, Philadelphia, Baltimore, near the falls of the Potomac, above the city of Washington, where the line curves in a more southerly direction to Richmond, Weldon, Raleigh; and turning westward, it crosses Savannah River near Augusta, and gradually disappears in the region of Macon, Ga. This geologic feature extends in an indefinite way past Montgomery. It is easily followed by the geologist from New York to Macon, past the streams that flow into the Atlantic, until streams are reached which fall into the Gulf of Mexico. This line of displacement has an interesting geologic history. The rocks to the west and northwest are of Archæan age; the rocks to the east and southwest are mainly of Cretaceous, Eocene, and Neocene age. The line or narrow zone separates hard, dark, crystalline schists, traversed by veins of white quartz that are of ancient geologic formation, from gravels, sandstones, shales, and clays, that make up the rocks of later origin. Since the beginning of Cretaceous time, a zone extending from the monoclinal flexure to the sea has passed through several vicissitudes of history, at times being dry land as it is now, and at times being sea bottom. So the shore of the sea has oscillated slowly back and forth across this part of the Atlantic Plain. Along the advancing and receding coast, gravels have been piled by streams coming from the landward side, and with them sands and clays have been deposited; but the finer materials have always been carried farther into the sea, and the coarser materials left near the shore. In studying the rocks of which the plain is composed, as they are exposed in stream banks and bluffs, and as they are revealed in digging and boring wells, alternations of gravel, sand, and clay are discovered; and the gravels usually increase in thickness toward the northwest, and thus appear to be shore deposits along an advancing or receding coast. Distinguished so clearly by geologic features, the topographic characteristics of this zone are even more plainly marked. The line of flexure is everywhere more or less clearly defined as a terrace broken by valleys and stream channels. In the streams the line is still more marked, for everywhere they cross it in rapids and falls. Far above there are rather swift-flowing but quiet reaches; at the flexure they plunge down with rolling, turbulent currents, and fall into broad channels with placid waters. Below, all the streams of magnitude rise and fall with the tides; above, all the streams rise and fall with the great storms; while along the narrow zone of flexure the clear waters are transformed into rushing torrents by long-continued rains. Here we find the great water powers which have been utilized ever since the early settlement of the country; and here we find the barrier to navigation, for the vessels that come from the Atlantic coast cannot be navigated across the fall line, and all boat transportation from below ends here. A few of the streams can be navigated above this line; but their cargoes must be carried over the fall line and reshipped, to reach the streams below. The zone of displacement is thus marked by characteristics which divide the country above from the country below in a double way. It is the zone of water powers and the zone of interrupted transportation by water. Under these circumstances the fall line was well marked in primeval times, ere yet the white man had settled in the land, for a line of Indian villages extended along it from the Hudson to the Savannah. Later, under the ægis of civilization, cities were built at this line, with convenient water power for manufacturing purposes, and easy means of commerce with the old country by the sea, and with the interior by rivers, canals, and roads. Thus, unconsciously to the savage and unconsciously to civilized man, geologic conditions fixed the sites of ancient villages and modern cities at the head of tide water and in the region of the great water powers. From this fall line a great plain extends to the coast, marked by few hills, and slightly terraced with bluffs on the margins of flood plains. Near the coast and along the flood plains extensive marshes are found. This irregular zone of marsh is clearly distinguished from the higher plain. A lower plain extends from the coastal marshes out to the sea for many miles, until at last shallow waters change into deep waters, and the bottom plunges down with steep declivity into the depths of the Atlantic. This

Atlantic plain is therefore naturally divided into three great zones,—the *subaërial* portion; the *marsh* portion, which is covered more or less intermittently with water by tides and storms; and the *submarine* portion, which extends out to deep waters.

Above the city of New York the marine portion of the plain expands, while the marsh portion is usually narrow, though sometimes it extends back into the high land many miles; but it is often broken, when higher lands extend down to the tide, and the submarine plain is separated from the subaërial plain only by sea cliffs. In this northern region the land portion of the plain is very irregular: in some places it is narrow, in other places it expands to considerable width, but altogether it is much less conspicuous than it is below the Hudson. South of Macon, Ga., there is an irregular line of parting between the waters of the Atlantic and the waters of the great Gulf. That portion which drains into the Atlantic is still called the Atlantic Plain, and it thus embraces a part of Florida down to the Keys. Off southern Florida the submarine portion is greatly narrowed, while the marsh portion expands into the great marshes of Florida, which extend from the ocean to the Gulf.

The land plain is usually rich agricultural land, and is extensively cultivated. The marsh plain has a wealth of deep soil, and wherever redeemed by drainage or embankments it yields bountiful returns to agricultural labor. The sea plain is the site of a coastal commerce which has already attained great magnitude, and which is steadily growing. The scenery is monotonous in relief, but wonderfully varied with bays and gulfs, and broad, quiet rivers, the banks of which are diversified with stately groves. From the palmetto of the South, to the low, gnarled oaks of the North, there is a panorama of ever-changing forests. At the South, coral groves abound, which unite with sediments from the land to build fringing islands. Northward from the coral homes great rivers loaded with sediment supply sands that are deposited by the currents, and by the waves are built into other fringing islands all along the marine plain until we reach the great sand banks of the North. In a few places there are diastrophic islands, and behind them there are great harbors, as in New York Bay. Especially along the coast of New England there are many diastrophic islands, and from New York to Boston they protect quiet sounds that are utilized by commerce in great fleets, whose white sails skim the sounds all summer long.

Along the coast of Maine the tides sometimes rush up the rivers in great bores, and the rock-bound coast is protected by sea cliffs. On this beautiful Atlantic coast the traveler may sail from coral reefs to seas where icebergs float, and may return by the steel highway from cranberry gardens to orange groves.

THE PIEDMONT PLATEAUS.

The Piedmont Plateaus lie west and northwest of the central portion of the great Atlantic Plains. The rocks of which they are composed are mainly of Archæan age, and are all more or less metamorphic. Often they are of slaty structure; that is, the sedimentary beds originally laid down in strata have, by diastrophism, compression, and chemical change, become metamorphosed; ofttimes the old stratified structure has been destroyed and a new structure imposed upon the rocks, so that they appear in thin plates which do not conform to the old stratified planes. This structure, given by metamorphism, is known as *slaty* structure. Besides the original sedimentary beds, primarily there were great bodies of lavas, and these also have been metamorphosed. During Cretaceous time, while the Atlantic plains to the eastward were sometimes land plains and sometimes submarine plains, and while the coast line was shifting back and forth, the Piedmont region was degraded to a great system of plains which were traversed by streams running to the sea. The whole plain seems not to have been brought down to the level of the sea, but to have inclined slightly to seaward and toward the valleys of the streams; so that, in referring to its plain condition, the region is often called a *peneplain*. When the land portions of the Atlantic Plain were finally unmasked by the upheaval of the land and the retreat of the sea, the same system of upheaval extended throughout the Piedmont region, and has continued with intermission to the present time, until the old plains have now reached an altitude which constitutes them plateaus, as that term is now defined. We have already shown that the Piedmont region is narrowly defined on the Atlantic side by the fall line, which separates it from the plains. On the northwestern side it is bounded by the Appalachian Mountains. The line of separation between these two regions is not always as clearly defined as that on the other side, and yet in the main it is distinct.

The region had a great extension of plains, sometimes diversified with many hills, before its upheaval into the plateau condition. In various places there were areas of quartzite which were hard and unyielding to degradation, and which remained as hills. In other regions there were bodies of firm granite, probably of volcanic origin, which also resisted degradation and remained as hills. Over the old plain surface these ancient hills still remain to crown the plateaus. As the upheaval began, the plain was tilted eastward, and the sluggish streams were urged to greater activity, until they became swiftly rolling rivers and creeks, and even the brooks danced in joy with the new activity. With this new-born life they began to corrade their channels and to cut them in deep gorges, and gradually they carved out valleys, and divided the old plain into plateaus separated by luxuriant valleys with meandering stream channels and flood plains; while the hills on either side ascended to ancient plains, now plateau summits with their embossed hills. As corrasion presses hard upon upheaval, channels are cut more rapidly than the general surface is disintegrated and washed away, and for this reason the lateral stream gorges and valleys have a slightly convex profile; but when upheaval ceases, convex profiles are slowly changed to concave profiles. By this characteristic geologists often discover important time relations between diastrophism and degradation. From these characteristics of convexity and concavity, and from certain related facts, it is known that the Piedmont Plain was not upheaved evenly and simultaneously in all its parts, but that it was lifted now at one place and now at another. Where first lifted, the gorges and valleys are convex; where last lifted, they have concave profiles. There is not space here to characterize fully the Piedmont region in this respect, but reference will be made to one of the districts which has been uplifted in very late geologic times.

The Susquehanna River, which debouches into the head of Chesapeake Bay, is well marked by rapids at the fall line near its mouth; but above, swift waters continue, crossing the Piedmont Plateaus up into the mountain region. In late geologic time, tide water extended through this reach of the river in a broad, shallow channel which carried fresh water from above. By the last upheaval and tilting in this stretch from the fall line into the mountains, the flow of the river was accelerated, and the swift waters have mainly swept away sediments that had accumulated on the bottom of the channel and along the old flood plain. Yet this upheaval was late, and may be yet in progress; so that sufficient time has not elapsed to carve a new channel in the old rocks below, but only enough to carry away the greater part of the soft materials,—the ooze and sediments that gather on the bottom of the old broad-cut river. The old bottom of hard rocks was very irregular as a floor; and as the soft rocks have been carried away, this irregular surface appears. Many channels in the hard rocks have been cut, and the irregularity is now even greater than it was originally. For this reason the Susquehanna falls into a very broad, shallow channel, beset with great bowlders and bordering ledges of rock; and it often runs in many channels, while patches of sediments that lined the old river bottom still remain here and there. It is thus that history is recorded in river channels, graved in glyphs by corrading streams.

Many fissures in the metamorphic rocks of the Piedmont Plateaus have been filled by the deposition of white quartz once held in solution in the underground waters. In this manner extensive veins of the white crystalline mineral ramify through the rocks, which are usually dark and somber, but are enlivened with the veins of crystalline quartz. In these veins minute fragments of gold are discovered throughout the Piedmont region. Ever the shining metal has attracted the eye of civilized man, and gold mining has been extensively practiced; but the quantity found has never been very great, and usually the quartz veins have failed to remunerate labor.

THE APPALACHIAN RANGES.

These ranges extend from southern New York into the State of Georgia. On the southeast the Piedmont Plateaus stretch from the foothills of the mountains. On the northwest the great Alleghany Plateaus lie, joining the Lake Plains in the region of the Great Lakes, and the Prairie Plains in the region of Ohio River. These mountain ranges are composed mainly of ridges whose longitudinal direction is from the northeast to the southwest. Between these ridges valleys are found. Usually a valley separates the mountain region from the Alleghany Plateaus. This system of mountains is naturally divided into two parts, the northern Appalachian and southern Appalachian ranges. On the north the streams heading in the Alleghany Plateaus run southeastward into the Atlantic Ocean, and cut through the ranges by great gorges that are popularly called *water gaps;* but south of New River the Appalachian Ranges are drained into the Gulf. The streams head in the crest of the most eastern range, and cut through the ranges to the west by flaring gorges, and most of them empty into Ohio River by the waters of Cumberland and Tennessee rivers. In early Cretaceous and Juratrias time the Appalachian Mountain and the Alleghany Plateau regions were reduced nearly to a base-level. In Cretaceous time these regions were again lifted by diastrophic agencies. The northern plateaus were tilted in a manner which turned their waters toward the Atlantic, while the southern plateaus were lifted in such a manner that their waters were turned toward the Ohio; so that now we find the Delaware, the Susquehanna, and the Potomac rising far to the northwest in the Alleghany Plateaus, and flowing southeast across the Appalachian Ranges to the Atlantic, while New River and the tributaries of the Tennessee rise far to the southeast in the Blue Ridge, and flow northwest across the Appalachian Ranges and the plateaus beyond to the Ohio. The two portions were further differentiated by reason of a great distinction between the methods of interior diastrophism. The folding of the northern Appalachian Mountain belt was more regular in great anticlinal and synclinal flexures, while in the upheaval of the southern mountains the folds were crowded together and often faulted on a gigantic scale. These ancient folds were planed down when the whole region was brought nearly to a base-level, and the new valleys cut on the later upheaval were carved mainly in soft rocks, while the mountains that are left are composed mainly of hard rocks. The valleys, therefore, do not follow downturned flexures, but lie along out-cropping edges of hard beds, while the streams themselves from time to time cut through the ranges by flaring gaps. In the same manner in the southern mountains, hard rocks make mountains, and soft rocks produce valleys; but these valleys are less regular below, because of the great lateral thrusts by which the strata were closely plicated and often faulted. Usually the valley between the mountains and the Alleghany Plateaus is wider, and is a more conspicuous feature, than the other inter-range valleys. The ridges themselves are rather monotonous mountains, but in the water gaps picturesque scenery is found.

The valleys that are regular and beautiful are highly cultivated and densely populated.

ALLEGHANY PLATEAUS.

In a broad way these plateaus are carved out of a great block of sedimentary rock tilted to the northwest from the Appalachian Mountains down to the Prairie and Lake plains. In Cretaceous and Juratrias time the block was graded to a plain, the surface of which generally conformed to the stratification. The great block is slightly warped, and there are many local evidences of minor diastrophism. In general the plateaus are crossed by deep, comparatively narrow water channels. As the streams run in deep channels, all the larger ones being in gorges from two hundred to a thousand feet in depth, the dissection of the plateau block is often minute, and many plateaus are thus formed. The region of the Piedmont Plateaus, Appalachian Mountains, and Alleghany Plateaus, in its earlier geologic history, extended farther to the northeast, and gradually faded out; but its structure is still preserved, though more or less masked by glaciation. It is even to be observed in the Green Mountains of Vermont, as well as in the Berkshire Hills of Massachusetts, which constitute a part of the Green Mountains. But north of the Piedmont Plateaus the region has been carved by glaciation and masked by glacial hills, so that it is best described by itself.

NEW ENGLAND PLATEAUS.

In this and the two preceding monographs mention has been made of the action of glaciers in grading the land, but the subject did not receive adequate treatment for want of space. Yet in characterizing the physiographic regions of the United States it becomes necessary to say something more of the action of ice, and of the history of a time known as the glacial period.

The most of Greenland is now covered by ice. Ice is found over great areas of the northern extremity of this continent and far down the Pacific coast. At different times in the Pleistocene period this ice capping of the land reached much farther southward. There was one great body of ice, known as the Laurentide Glacier, which extended over Canada and other parts of British America down into the United States, its most extreme lobe reaching to a point in the Mississippi Valley not far from the mouth of the Ohio. Geologists have shown that it covered an area of about three million square miles. There were other great glaciers farther west which we need not here consider.

The Laurentide Glacier endured for a long time, and passed through many phases of history. Perhaps it existed at two or three different times, with intervening periods of milder climate, when it was melted. In its greatest development it must have accumulated to a thickness of hundreds or thousands of feet. Its different portions were ever moving on the surface of the land, and grinding up the rocks below, and pushing them down the slopes in a general way to the southward, with many variations. The rains fell upon this glacier through the centuries, and the sun melted the ice, and the water percolated to the surface of the ground, and flowed away in subglacial streams that carried with them the rock-flour ground by the ice, which was armed with rocks carried along by the ice. It is thus that the great glacier served as a mighty agency for the degradation of the land, pushing the bowlders and ground material along its bottom, and carrying it away in channels, often piling it up in moraines, drumlins, kames, eskars, and other forms, and spreading the finer materials in great sheets of clay and fine sand.

A portion of the Laurentide Glacier was expanded over New England and New York down to the very site of the great city. Over this region it extended for a long time, though its existence may have been intermittent; but it remained long enough to accumulate masses of ice with power to perform the stupendous task of refashioning the surface of the land. It found mountains, plateaus, plains, valleys, and hills, but it changed them all by carving new forms to its own liking; but, more than all, it built a vast army of hills, and filled many valleys. The modified mountains yet remain; the old plateaus, though changed, still stand; but the valleys and hills are to a large extent new features. I have called this region the New England Plateaus because before the advent of the ice it was a great group of plateaus diversified with mountains, hills, and valleys. Now new hills are found widely scattered over it, sometimes in its valleys, always over its plateaus and over the flanks of its mountains. The Adirondacks still stand, much modified by glaciation. Down Vermont the Green Mountains extend into the State of Massachusetts, where they are called the Berkshire Hills. Everywhere they have been remodeled by ice. Still to the east, in New Hampshire, are the White Mountains, with Mount Washington as a culminating peak; and there are lone mountains scattered over Maine, and the region extends beyond our boundary into British territory.

The structure of these plateaus is more or less masked by glacial hills, and there are great valleys with river plains exhibiting fragments of ancient glacial hills. Near the Atlantic the coastal plain is broken, and many sea cliffs are found, and the coastal marshes are very irregular. In New York, glacial valleys and more recently cut river valleys are found, and limited plains are seen, especially in the region of the Finger Lakes. Scattered through the region are many lakes of clear, cold, beautiful waters; and there are many marshes, some fed by the tide with salt water, but many more with fresh water; and the interior lakes are mainly of glacial origin.

LAKE PLAINS.

In the northern portion of the United States there is a lake region which extends still northward far into British America. In the midst of the region lie the Great Lakes, — Ontario, Erie, Huron, Michigan, and Superior; and about them, to north, south, east, and west, many others are found of less magnitude, to the number of thousands. The region is in large part drained by the St. Lawrence, and in small part by the Mississippi. The Great Lakes are primarily of diastrophic origin, but they have all been remodeled by ice, while the smaller lakes are due mainly to glaciation. The great Laurentide Glacier extended over all this region, and buried it deeply under the ice, and during its history made great changes in the land surface by degrading old forms, and building new lands.

Previous to the advent of the glacial age, the region was in the main a system of great plains, with hills and some minor plateaus; but when the ice came, it covered them all, and wrought a regeneration, leaving the Great Lakes still lying in their diastrophic basins, but adding to the region a vast assemblage of glacial lakes, many of which remain, while many have been filled with peat, and drained by new stream channels. The plains left by the glacier were low, with comparatively little relief.

Since the disappearance of the ice sheet, diastrophism has progressed as of old; so that the Lake Plains have been warped, and it becomes easy to identify these diastrophic changes. As it is a region of many lakes, and as the streams have all been corrading new channels since the disappearance of the ice, the great and small lakes have often been terraced. The greater plains have in this manner been cut into small lake plains that are low stairways from shores to high lands. Thus the region is characterized by great plains base-leveled in earlier geologic periods, releveled during the glacial period, and terraced with lake plains since that time. By reason of its many lakes and its numerous terraces, it is well characterized as the region of Lake Plains. Four districts may be recognized, as shown on the map.

PRAIRIE PLAINS.

On the south and on the west of the Lake Plains stretch the great Prairie Plains. When this region was first visited by white men, much of it was destitute of forests. In the east, glades and small prairies existed; farther westward the prairies became larger, until, in eastern Indiana, the prairie region prevailed in extent over the forest region, while beyond the Mississippi the prairies were interrupted only by the groves that border the streams. This prairie region sweeps around the great Ozark Hills, and extends southward nearly to the Rio Grande del Norte. Here and there it is relieved by low hills, and it is cut with a labyrinth of stream channels, on the borders of which flood plains appear that were usually covered with trees in the olden time. The Laurentide Glacier extended across this prairie region down nearly to the mouth of the Ohio; and wherever it was spread, great glacial accumulations appear as beds of clay, sand, and gravel, and sometimes as glacial hills. On the last retreat of the ice there were left behind many little basins, into which the waters were gathered; and a multitude of little lakes were thus formed, many of which were gradually drained by the streams, and filled with peat. It is thus a region of small extinct lakes, whose shores were rarely terraced because of the brief life awarded to these little bodies of water.

On the west the prairies merge imperceptibly into the region popularly known as the "Great Plains," but which we now call the Great Plateaus, for the reason hereafter to appear.

The lands of the prairies are fertile. Douglas Jerrold said, that, if you tickle them with a plow, they will laugh with a harvest. When the country was first settled, the districts far away from standing timber were supposed to be almost uninhabitable for the want of fuel and timber; but under the prairies vast coal fields have been found, and the men of the prairies have learned to fence with hedges and iron wires, and they have built railroads, on which they have carried the lumber necessary for their homes. The agricultural industries of all that land have flourished. Gradually the lowlands have been drained and tilled and the higher lands have been plowed, forest groves have been planted and the old woods have spread, thousands of orchards have been grown and vineyards have been planted and gardens cultivated, until a greater proportion of the land has been brought under the plow than that of any other region of the world of the same magnitude. Two districts are shown on the map,—the one glaciated, and the other not.

THE GULF PLAINS.

On either side of the Mississippi River, from a little above the mouth of the Ohio, a great plain stretches to the south, and expands to the Gulf waters. On the east the border of this plain skirts the Alleghany Plateau and the point of the Piedmont Plateau, and extends east to the line of parting waters between the Atlantic and Gulf drainage, which it follows into the marshes of lower Florida. On the west it flanks the foot of the Ozark Mountains, and continues southwestward to the Rio Grande del Norte. All of this area we call the Gulf Plains. Down its middle the Mississippi runs, and along the Mississippi and up its important tributaries there is a great flood plain. Thus the Gulf Plains are divided into five great districts,—the East Gulf Plain, the West Gulf Plain, the Flood Plain of the Mississippi, the Coastal Marshes flooded by salt water from the Gulf itself and by fresh water from the land, and the Submerged Plains extending into the Gulf, so that there is a submarine portion, as on the Atlantic coast. Under the waters of the Gulf, far out at sea, the submarine plain is ended by a comparatively abrupt declivity, where the Gulf bottom drops off from shallow into deep waters.

The Mississippi Flood Plain starts at the foot of the great glacial deposits in Illinois, and at the Gulf end it expands into a great delta built into the Gulf by sediments brought down by the mighty river. This flood plain is usually well marked around its outlines by high bluffs of *loess*. During glacial time the Gulf coastal plain seems to have been somewhat more depressed than at present, and the water of the glacier gathered into a great basin which emptied into the Gulf. In this basin the rock-flour ground by the mealing stones of vast glaciers was deposited as an exceedingly fine sediment. When the Laurentide Glacier was melting away into fragments in the far north, the land rose again a little, and the Mississippi cut for itself a new channel, which was widened into a flood plain. The material into which the channel and the flood plain were cut was of glacial origin, and we call it *loess;* and thus the bluffs are of this formation. The Gulf region is rich with fields of corn, tobacco, and cotton.

In pre-Columbian times the entire region was a primeval forest of giant trees and dense undergrowth entangled with vines. Into these forests aboriginal tribes penetrated to fish in the waters, to hunt on the land, and to cultivate little garden patches in corn and squashes. Here they built mounds on which their homes were erected; here they buried their dead in mortuary mounds; and here they constructed great tumuli upon which stood their council chambers, and where their ceremonies were held. On these artificial hills they established their tribal homes; worshiped the sun, moon, and stars, and many animals; organized tribal governments of elaborate structure; and enforced laws that secured a high state of justice.

THE OZARK MOUNTAINS.

Extending southward and westward from the Iron Mountains of Missouri far into Arkansas, there is an elevation of land which we call the Ozark Mountains or Ozark region. This region has an interesting though complex history. It is properly divided into two districts. That north of Arkansas River has been a great plateau, and still retains many of the features of a plateau, but it is deeply trenched by numerous winding and complicated streams; and the reliefs or elevations which have been preserved have the structure of huge hills and small mountains, though a few of the forms are of more gigantic structure. Some of the greater elevations above the streams are in the Iron Mountain region, and others are called the Boston Mountains. The rocks are sometimes faulted, and the streams often follow fault lines. In the Boston Mountains the strata are chiefly horizontal, and are deeply channeled. On the south the rocks of this region in a general way bend down in a synclinal fold, and reappear south of the river; below they are found strongly folded and sometimes faulted, and are eroded into long, parallel mountain ridges with intervening valleys. Going southward, the ridges have a general east-and-west trend, but are often curiously carved and faulted. In the most southern portion of the region the streams are transverse to the rock structure. It would be well to call the northern district the Ozark Plateaus, and the southern district the Ozark Ranges.

THE GREAT PLAINS (PLATEAUS).

The region popularly known as the "Great Plains" is in fact a great group of elevated plateaus. They have therefore been colored as plateaus, and grouped in districts which are called plateaus. It would serve to harmonize the nomenclature if the name could be changed from *plains* to *plateaus*. The zone in the United States extends from British America to the Rio Grande; and the region extends far northward in British America, and southward in the Republic of Mexico. Within the United States four districts are demarcated.

The Missouri district is deeply trenched by the upper Mississippi River and its great tributaries, in such a manner that the blocks to the north have their long axis extending from the northwest to the southeast, while the plateaus south of the river have their long axis extending from the southwest to the northeast. The principal streams of the region have their sources in the Stony Mountains, and carry large volumes of water, while the local tributaries are small. Along many of the smaller streams there are extensive areas minutely dissected by storm-water streams. The rocks are mainly soft shales, so that corrasion is rapid; and the hills thus formed in the easily carved shales are naked and desolate, and hence are called *bad lands*.

In the district to the south, called the Platte Plateaus, the rivers flow mainly in an easterly direction; and the trenches which they form divide the country into long table-lands having the same direction. The trenches are wider and shallower than in the north. The streams all join the Mississippi.

Going to the southward, the Arkansas Plateaus are found. The Arkansas, the Cimarron, and the two forks of Canadian

River, drain the entire district, and separate it into long east-and-west plateaus. The trenches of the rivers are not very deep, but are usually very wide, and their summits are great treeless plains. All these rivers join the Mississippi south of the Ohio.

The fourth district is drained mainly by the Pecos, having a southerly direction; but its eastern margin is drained by tributaries of Red, Brazos, Nueces, and Colorado rivers of Texas. This is the Staked Plains, the region best adapted to the study of the four great laws of corrasion, which may be stated as follows: —

First, other things being equal, the rate of corrasion progressively increases with the increase of the load which is the instrument of corrasion; *second*, other things being equal, vertical corrasion directly increases with the declivity of the stream; *third*, other things being equal, lateral corrasion increases inversely with the declivity of the stream, and vertical corrasion is transmuted into lateral corrasion; *fourth*, maximum corrasion is produced by maximum volume of water, maximum load, and minimum declivity, and the corrasion is lateral; *fifth*, a stream heading in mountains, and crossing arid lands, is supplied with a great amount of sediment by frequent winds and occasional hard rains, and is caused to spread in a wide channel, so that the depth of water is greatly diminished, while the sand, having but a short distance to fall, is driven along by short excursions: so that the rate of corrasion diminishes in inverse proportion to the depth of the stream.

THE STONY MOUNTAINS.

The Stony Mountains constitute a well-marked group drained by the head waters of the Missouri on the east, and the head waters of Snake and Columbia rivers on the west. The name "Stony Mountains" was first given to this group, but was afterward changed to "Rocky Mountains," and then extended indefinitely over other groups; but, as the group must be distinguished from others for physiographic purposes, it seems well to return to the original designation. These mountains appear to be of very diverse structure. There are a number of great ranges; but they are not very systematically grouped, and have different directions because they are complicated with vulcanic mountains, plateaus, and hills. Some are carved out of broad anticlinal folds, others are greatly faulted, and often sharp ridges appear; but the geologic history of the country has not been so fully worked out that a consistent story of it can be given. The ranges are moderately high; and, by reason of the northern altitude and a fair amount of rainfall, they are covered for many months with snow, and here many beautiful streams have their origin. The flanks of the mountains and high plateaus are often covered with great forests, and the low foothills with gnarled trees. The valleys are rich and productive, though mainly treeless. Great mining industries are prosecuted, especially of gold and silver. In the heart of the group are the geysers and hot springs of the National Park, which has become a region of world-wide resort because of its wonders and its beauty.

THE PARK MOUNTAINS.

In southern Wyoming, central Colorado, and northern New Mexico a great group of mountains is found, whose lofty peaks are characterized by a wilderness of crags. The ranges are more irregular than those of the Stony Mountains, and have a general north-and-south trend. Between the ranges there are great valleys, which are known as *parks.* The four most important are the North, Middle, South, and San Luis parks; but there are others which almost vie with them in extent, and a great number of still smaller valleys, all of which are alike called parks. Above the timber line the peaks are naked; below, on the flanks of the mountains, great forests stand, and often spread over elevated plateaus; while the valleys are beautiful prairies or parks. The ranges having a north-and-south direction are carved out of great anticlinal folds, but in each fold a zone of maximum curve is usually discovered on either flank; so that the rocks at the flanks of the ranges are abruptly turned down, and extend under the parks, and are again turned abruptly above to a nearly horizontal position. Only fragments of these more horizontal beds above have been left: most of them have been degraded away. The central portions of the ranges are in the main composed of metamorphic rocks of great age. This more irregular structure is modified to some extent by faults and various minor wrinkles. On the flanks of the mountains and out in the parks there are many beds of vulcanic rocks, which serve still further to modify the aspect of the ranges. In a few cases, especially on the western side, these vulcanic beds have been piled up in mountain forms. On the eastern side there are a few outlying peaks of volcanic origin. Notable among these are the Spanish Peaks. The group terminates to the south in the neighborhood of Santa Fe. The head waters of Platte, Arkansas, and Canadian rivers drain the mountains on the east; to the west they are drained by the head waters of Colorado River, which empties into the Gulf of California; while to the south they are drained by the Rio Grande del Norte. This is a land of ranges and valleys, of peaks and parks, of naked crags, forest-clad mountains, and plateaus.

There are features extending along the entire length of the group from north to south on the eastern side, and again irregularly on the western side, that give rise to many small and picturesque parks sometimes called *gardens*. It has already been explained that the rocks of later age are turned up sharply on the flanks of the mountains as sandstones, shales, and limestones of many colors, often of bright-red hues, while beds of alabaster are found. The rocks stand on edge. The softer beds are worn out, and the harder beds remain standing as great walls; so that many beautiful garden valleys are produced, parallel to the great ranges, and separating them from the plains below. The forms of these rocks are often varied and majestic, and sometimes fantastic. The Garden of the Gods, near Pike's Peak, is one of these valleys, which has become a favorite visiting place from the adjoining summer resorts.

COLUMBIA PLATEAUS.

To the west of the Stony Mountains stretches a great plateau region which is drained into the Pacific by tributaries of Columbia River. It is a complex of plateaus of diastrophic and vulcanic origin, relieved by a few great mountains, and having many beautiful valleys. The highlands are covered with forests; the lowlands are naked.

In Cretaceous time the region had many extensive plains, broad valleys, high mountains, and some portions were covered by the sea. The mountains were mainly of granite, quartzite, and mica schist, with rocks of later age on their flanks.

In Eocene time extensive diastrophism prevailed, and with it came vulcanic activity, by which a number of great mountain cones were erected.

In Neocene time the lavas were more fluid, and broke out in many new places, pouring out thin coulees, frequently filling or obstructing valleys. These later eruptions continued for a long time, upbuilding the region by burying the old topography and piling the lavas against the mountains. In the process, valleys were often dammed by floods of cooling lavas, and behind these obstructions many lakes were formed. Since vulcanism has ceased, many of these lakes have been drained, and the old lake beds are now rich agricultural lands. In many places the ancient mountain summits yet appear, but about them are scattered great irregular vulcanic plateaus. Small valleys have sometimes been carved, but often the streams have cut narrow trenches which are canyons. Frequently the canyon walls are composed of lavas, sometimes with interbedded lake beds. ~~In the old~~ mountain regions gold and silver are mined, and in many places the gravels left in the valleys and canyons below have much gold in nuggets, flakes, and dust, which gives rise to placer mining. Snake River runs for several hundreds of miles of its course through a canyon carved in the lavas. The walls of the canyon are often precipitous, effectually barring cross-river transit. In places late coulees have dammed the river; Shoshone Falls are formed in this manner. Here a mad torrent of water plunges over a great lava dam in a cataract of grandeur.

COLORADO PLATEAUS.

During the Cretaceous period a shallow sea spread over the region of the Colorado Plateaus. This great embayment of the ocean stretched far to the east, northeast, and southeast, and its oriental margin was a little east of where the Mississippi River now runs. In the midst of this sea there was a great archipelago where now the Park Mountains stand. In late Cretaceous and early Eocene time the entire sea was slowly upheaved, and the waters retreated. The upheaval was very irregular, and great diastrophic basins were formed, in which the fresh waters accumulated, and it thus became a great lake region. For a long time the waters were brackish, as the lakes evaporated to such an extent that only small channels were cut, such being sufficient to bear away the water not evaporated. In a broad way the upheaval in the eastern region was by gentle flexures; in the western region it was chiefly by faults. As the fresh-water basins were many and large, and the land areas comparatively small, the dry lands were washed down into the Great Lakes; but elevation proceeded faster than degradation, and the lands grew both by upheaval and by the enlargement of their borders through deposition, or, as it is sometimes called, aggradation. The slow upheaval continued through Eocene time. The western half became highly differentiated from the eastern half, as at the west diastrophism was more energetic, and at the same time vulcanism was inaugurated on a great scale. In the plateau region, which we now have under consideration, the diastrophism was chiefly by faults and monoclinal flexures, and the whole country was broken into great irregular blocks, mainly by lines having a general east-and-west direction, but in the southeast a north-and-south direction. At the north the blocks were tilted to the north, but there were many minor variations, and in the south they were tilted to the east. The blocks thus produced are the great plateaus, which were modified and dissected by rains and rivers. At the time when these movements began, the rocks immediately beneath the sea were lying in a horizontal position to a depth of many thousands of feet. When the land was thus upheaved in tilted blocks, the strata were slightly inclined; and the streams heading in the blocks tilted northward mainly ran northward, with branches from the east and west, and for a long time were gathered into lakes that drained into Colorado River, while in the south they drained chiefly east and south into the Rio Grande del Norte. As general upheaval went on, all the lakes were drained by the cutting of outlet channels, and the whole region became arid. All this was in early Neocene time. At last, in late Neocene time, the diastrophic blocks were trenched; and when the lakes were drained, their bottoms became valleys, and the valleys were then slightly trenched by streams running into the Colorado and Rio Grande del Norte. Thus plateaus of great diastrophic blocks were dissected by a vast network of streams. The upturned edges of the blocks were degraded by sapping, — a process which was described in a former monograph, — and diastrophic cliffs were carried back in great steps or terraces. In this manner the plateaus were still further dissected, so that the whole region is now a vast assemblage of great plateaus, divided into smaller plateaus by the channels of streams, and still further divided by cliffs produced by sapping. In general the entire region is a group of tilted blocks, whose higher edges terminate in great cliffs formed by sapping. There are a few cliffs which have not retreated far, and still mark the site of the faults; while there are other great plateau edges which are monoclinal flexures, and here the bent rocks yet appear. The great cliffs are everywhere adamantine structures of magnificence: they are terraced and buttressed, and cut with deep reëntering angles, and often set with towers, pinnacles, and minarets; they obstruct the traveler even more than mountain ranges; in fact, from the plain below, they appear as mountains built of naked rock. Where the rocks are limestones and hard sandstones, bold precipices are formed; but between these steep ledges the softer shales are often carved into a filigree of fantastic forms. A façade thus constructed of rocks of varying hardness in bands of many colors, in forms that resemble Titanic architecture, makes the scenery a constant wonder to the traveler. Where the edges of the plateaus are monoclinal folds, the inclined rocks are carved on another plan, giving variety to the scenery.

The streams usually have deep channels. Little rills born of showers and dying with the sunshine have often cut deep but narrow, winding gorges, at the bottom of which great caves are often found. The creeks have cut larger canyons, and the rivers have cut mighty canyons,—gorges sometimes hundreds of miles in length. So there are canyons along the rivers, smaller canyons along the creeks, still smaller canyons along the brooks, and picturesque canyons along the wet-weather rills; and the plateaus are thus divided by a labyrinth of deep gorges. While the diastrophism of the blocks has produced great plateaus, and while stream cutting and stream sapping have been dissecting them, vulcanism has been in progress; and old volcanoes are often found on the summits of the plateaus, and cinder cones are scattered in many places, and great sheets of lava have been poured out that have become the caps of table mountains, and other sheets have been piled one upon another so as to constitute imbricated mountains, and in a few places laccolitic mountains are found. Thus with cliffs, canyons, gorges, and volcanic mountains, the entire region is one of picturesque grandeur.

To the north there is a plateau known as the Uinta Mountains, having its greatest length in an east-and-west direction. It has a monoclinal flexure on each flank,—one at the north and one at the south. Between these abrupt flexures the rocks are gently carved. Like many other of the plateaus, the southern edge was upheaved much more than the northern edge. This plateau was dry land during a part of Cretaceous time, and there were islands here during Eocene time. In Neocene time the entire plateau became dry land, and from that time on, the rate of upheaval was comparatively great, and through this range great lakes to the north were drained into lakes farther south. So the upheaval went on as the plateau was lifted; but the river was able to carve its way through the plateau, and still remained an outlet for the upper lakes during all Neocene time. In this period it was upheaved more than twenty thousand feet, yet the river cut its channel and preserved its course during all the time. The river came from the north, and impinged on this block about halfway in its course from east to west, then made its way into the heart of the block, next turned eastward for sixty miles, and finally turned again to the southwest, until it left the block at its southern margin. So the canyon was cut through a bluff that was slowly lifted by forces from below.

The small streams have all trenched deep gorges, between which minor plateaus are found; and sometimes the trenching has left behind great peaks, so that the plateau has received the name "Uinta Mountains." It is largely covered with forests, but the deep gorges often have cliffs of naked rock.

In the southeast there is a great plateau, on the western side of the Rio Grande del Norte, opposite the Santa Fe Plateau. The block is about eighty miles square. It was upheaved from the west side along a line which presents a general north-and-south direction. It was not faulted, but upheaved in monoclinal flexure, bringing up the Neocene rocks, Cretaceous rocks, Juratrias rocks, and Carboniferous rocks. The Carboniferous rested unconformably on granite, and the granite also was brought up to an altitude several thousand feet above the little valleys on the west. Looking at the edge of this plateau from the west, it appears to be a great range of mountains. The block itself was tilted eastward and to a slight extent southward. As it came up, the Eocene, Cretaceous, and Juratrias rocks were all washed away from the western margin of the plateau, leaving a summit of granite; but going eastward, rocks of all of these ages appear in order from the older to the younger. As the block was tilted, there was very little vulcanism on its western flank, but on the east vast bodies of lava and ashes were poured out, so that on this eastern margin of the block great volcanoes were erected. The emission of matter from below was accomplished to an unusual extent by explosion, so that vast quantities of ashes were ejected, and these blew over the plateau, and thus beds of ashes scores and hundreds of feet in thickness were formed. As the volcanoes and ash beds were constructed, the main trend of the drainage was turned southward through Jemez River and its tributaries by a ramifying system of streams from the north, east, and west. These streams have often carved deep, narrow canyons, that reveal the structure of the vulcanic rocks above, and the sedimentary rocks below. Space forbids the further description of this beautiful plateau, with its granite range on the west, its volcanic peaks on the east and north, its beautiful valleys among the dead volcanoes; with deep gorges through which streams run, and hot springs that flow from the vulcanic rocks, and curious little faults that appear here and there, and strange forms that have been produced by corrasion, and lakes that have been filled and drained, and the forests with which the plateau is crowned.

To the south the San Francisco Plateau is found,—a tableland of great extent. It was upheaved as a block from south of west, and tilted to the east. All the Eocene and Cretaceous rocks have been washed away from its summit, and are found only on its flanks; but portions of the Juratrias remain. Through Eocene time it was deeply trenched by many streams. In Neocene time vulcanism prevailed, and a great system of volcanoes was built, and many cinder cones are found; often old channels were filled with lava, cinders, and ashes. The plateau is quite elevated, and the rainfall is nearly twenty inches annually; but the waters thus falling on the surface sink away into the lavas, cinders, and ashes, and are gathered below at a great depth in the old stream channels. Sometimes these underground waters excavate great caves below, and then the upper rocks fall in, so that many sinks are formed. In one of the cinder cones a crater lake is found, and scattered over the plateaus are many wonders. It is covered with a great forest, with intervening prairies that are gardens of wild flowers in midsummer.

Only three of the plateaus of the great number are described, but they serve as types for the entire region.

THE BASIN RANGES.

South of the Columbia Plateaus, and west and south of the Colorado Plateaus, is the great region of the Basin Ranges, extending far down into Mexico. It is a region of isolated diastrophic ranges, usually having a north-and-south direction, and often complicated with vulcanism. The blocks out of which the ranges are carved are uplifted abruptly, mainly by faults, but occasionally by steep monoclinal flexures, so that the rocks usually dip gently away to the other side. These simple diastrophic blocks are often greatly modified by vulcanism, and the lava from below is often piled up in peaks and small plateaus, while occasionally volcanic cones are found. The mountains are never high, and are often destitute of large trees, and sometimes are mountain deserts. Between these isolated ranges there are broad valleys with small branches extending into the mountains. The great valleys below are diastrophic basins which receive the sands and gravels washed down from the mountains, and are filled to the present surface from great depths below. In the mountains themselves narrow valleys have been trenched. Down these the streams flow until they are lost in the sands, so that their waters are not carried to the sea. Sometimes there are salt lakes in the valleys. Of these, Great Salt Lake and Pyramid Lake are the more important examples. In early Pleistocene time there were many more lakes of this character; and, as the climate was more humid, some of them, at least, found outlets to the sea.

The region is naturally divided by the Colorado River of the West. The district to the north is characterized mainly by closed basins, though near the Pacific Ocean there are many filled valleys which drain directly into the sea, and near the Colorado there are few. Southeast of the river all the basins have wet-weather drainage channels into the great river itself and the Gulf of California, or into the Rio Grande del Norte and Gulf of Mexico. The entire region is arid, usually having less than ten inches of rainfall annually over the filled basins. It is the desert region of the United States. The region east of the Colorado may ultimately be distinguished by another name: "Sierra Madre" would be appropriate. The mountains are more diverse, and the valleys more deeply trenched.

PACIFIC MOUNTAINS.

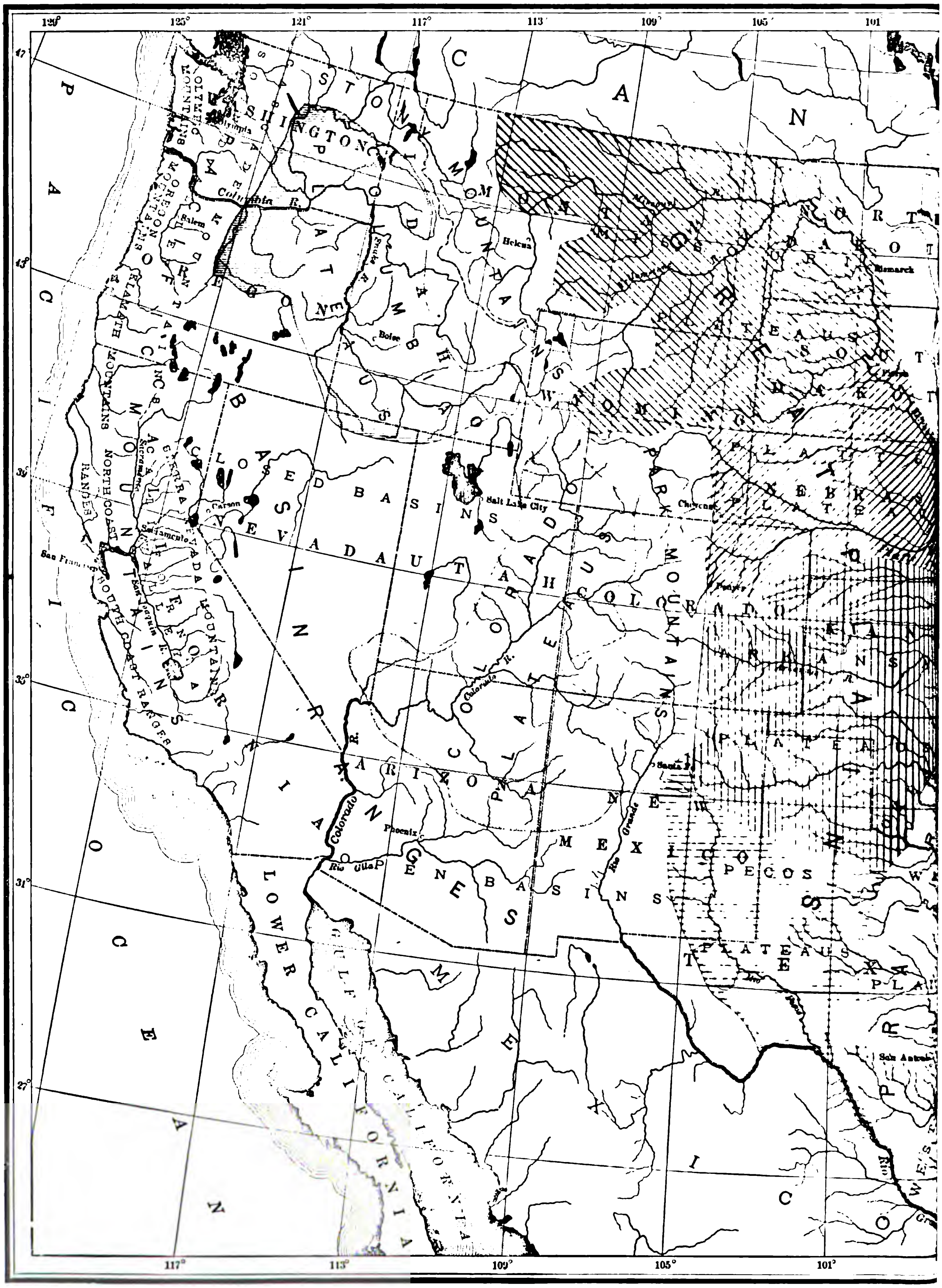
This is a great group of mountains and intervening valleys. The Cascade region is a diastrophic plateau on which vulcanic plateaus have been piled, and on them great volcanoes were elevated which are now extinct. The most picturesque peaks in the United States south of Alaska are here found, and in their gorges glaciers yet remain. From the crater of one of the volcanoes in Oregon there have been vast explosions, by which ashes and cinders were scattered widely over the adjacent country, and afterward the rocks about the crater fell into the depths below. The basin thus made has been deeply filled by snows and rains, and a lake has been formed of great extent and depth, known as Crater Lake. To the west of these mountains a river flows northward into the Columbia. The upper part of the valley is comparatively narrow; but along the lower two thirds there is a broad stretch known as the Sound Valley, which is formed by the upheaval of the Cascades on the east, and of the mountains near the coast on the west. At one time an arm of the sea extended up this valley in a great gulf, and since that time the land has been somewhat uplifted. It is thus a constructed valley between mountain ranges, and has been partly filled with sediment. To the west the Olympic Mountains stand on the north of the Columbia. The structure of these mountains is unknown. South of the Columbia, near the coast, are the Oregon Mountains, often called the Oregon Coast Ranges.

South of the Sound Valley and the Oregon Ranges there is a very irregular group of mountains, drained in part to the Columbia, in part to the Sacramento, but in chief part directly into the ocean. It is an upheaved archipelago known as the Klamath Mountains. South of the Cascade Range stand the Sierra Nevada. It is a great block upheaved from its eastern margin, and tilted westward. The displacement is by a complicated system of faults and folds, along which there has been much vulcanic action; and the coulees of lava have often obstructed the valleys, and formed lakes which have sometimes been filled by sediments until they were drained away. One of these streams, Truckee River, has its source far back in the block. In late Pleistocene time a series of coulees poured across it, and built a dam many hundreds of feet high, behind which Tahoe Lake has been gathered, until now it runs over the dam, in which it has cut a small channel. Elsewhere in the Sierra there are other lakes having interesting histories. As the block tilted westward, the drainage is chiefly in that direction. The irregular streams have carved out many flaring, steep gorges, between which mountain ridges stand, diminishing in altitude to the valley of California. Along the western flank there has been much vulcanism; and the coulees have formed many plateaus which have been trenched by the streams.

To the west of the valley stand the North and South Coast ranges, which are mainly anticlinal folds, sometimes compressed and faulted, and very much broken into fragments. These coast ranges are severed where the San Joaquin joins the Sacramento and flows through the Golden Gate into the ocean. The bays about San Francisco are diastrophic basins modified by gradation. The valley of California is naturally divided into two parts, — the northern valley, drained by the Sacramento; the southern, by the San Joaquin. They are naturally treeless, gently rising to the mountains on either side. Not long ago geologically the sea occupied these valleys as a great gulf; but they have since been upheaved, drained, and covered with a deep accumulation of clay and sand washed from the mountains.

The scenery of the Pacific mountain region is greatly diversified, and has many contrasting features. The extinct volcanoes of the Cascade Range have towering peaks that are covered with snow during many months, whose glittering crowns, revealed through vistas of forest land or seen from the far-away ocean, ever inspire delight. With green forests below, gray slopes above the forests, and peaks of silver, their symmetry is wonderful. This aspect of the mountains entirely changes as the mountaineer ascends from valley to mountain height; then the wooded slopes are transformed into deep gorges covered with evergreen forests of giant trees; the gray zone above is transformed into crags, towers, and minarets of many but quiet colors; while above is the zone of silver, with its snows and glaciers. So the mountains are in uniform, — green, gray, and silver, — all resplendent in noonday sun. When the clouds come, the peaks are masked; but as they vanish or roll away, a changing panorama of splendor is presented.

The Sound Valley is mainly covered with forests of trees, tall and stately. Among the venerable giants younger generations


129°
125°
121°
117°
113°
109°
105°
101°
47°
43°
39°
35°
31°
27°
PACIFIC OCEAN
CANADA
OLYMPIC MOUNTAINS
WASHINGTON
CASCADE
Olympia
Columbia R.
Salem
OREGON
COAST MOUNTAINS OF OREGON
KLAMATH MOUNTAINS
NORTH COAST RANGES
SOUTH COAST RANGES
SIERRA NEVADA MOUNTAINS
Sacramento
San Francisco
San Joaquin
CALIFORNIA
Carson
NEVADA
CLOSED BASINS
BASIN RANGES
COLUMBIA PLATEAU
Snake R.
IDAHO
Boise
MONTANA
Helena
ROCKY MOUNTAINS
WYOMING
Salt Lake City
UTAH
Cheyenne
PARK MOUNTAINS
Denver
COLORADO
COLORADO PLATEAUS
Colorado R.
ARIZONA
Phoenix
Rio Gila
NEW MEXICO
Santa Fe
Rio Grande
MEXICAN BASINS
PECOS
NORTH DAKOTA
Bismarck
SOUTH DAKOTA
Pierre
MISSOURI PLATEAUS
Missouri R.
Yellowstone R.
NEBRASKA
KANSAS
Arkansas R.
GREAT PLAINS
TEXAS
PLATEAUS
San Antonio
MEXICO
LOWER CALIFORNIA
GULF OF CALIFORNIA
117°
113°
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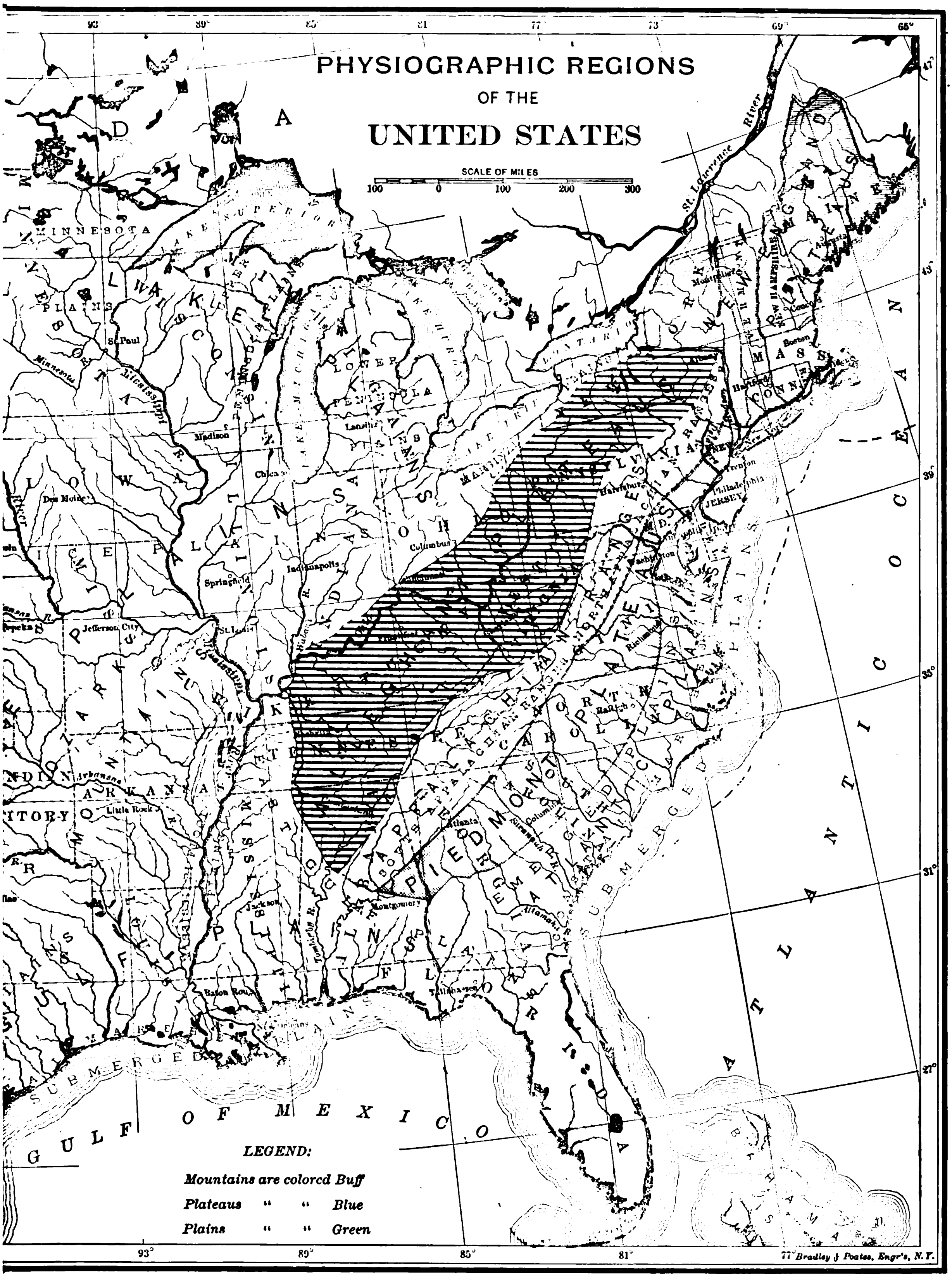
101°


PHYSIOGRAPHIC REGIONS
OF THE
UNITED STATES
SCALE OF MILES
100
0
100
200
300
LEGEND:
Mountains are colored Buff
Plateaus " " Blue
Plains " " Green
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
St. Lawrence River
MINNESOTA
IOWA
MAINE
NEW HAMPSHIRE
MASS.
CONN.
JERSEY
St. Paul
Madison
Chicago
Des Moines
Springfield
Indianapolis
Columbus
Lansing
St. Louis
Jefferson City
Little Rock
Jackson
Baton Rouge
New Orleans
Montgomery
Atlanta
Columbia
Raleigh
Richmond
Washington
Harrisburg
Philadelphia
Trenton
Hartford
Boston
Concord
Montpelier
Augusta
Albany
Tallahassee
Savannah R.
Altamaha R.
Minnesota R.
Mississippi R.
Arkansas
Tombigbee R.
LOWER PENINSULA
OZARK MOUNTAINS
PIEDMONT PLATEAU
ATLANTIC PLAINS
GULF PLAINS
SUBMERGED PLAINS
APPALACHIAN RANGES
FLORIDA
BAHAMAS
ATLANTIC OCEAN
GULF OF MEXICO
93°
89°
85°
81°
77°
73°
69°
65°
47°
43°
39°
35°
31°
27°
Bradley & Poates, Engr's, N.Y.

live; and pines, hemlocks, and cedars lift their bourgeoning heads to vie with their elders. On the ground dead and prostrate trunks lie, while others recline against the living. Among the dead and living trees there is an elaborate interlacing of vines, creeping, climbing, twisting, and weaving a woof of vine in a warp of branches. Over the mountains to the west these forests extend, losing but little of their luxuriance.

Descending from Mount Shasta into the valley of the Sacramento, the northern end of the great valley of California, cinder cones are seen in great numbers. On these cones the rains and snows fall and sink away, to reappear far away in great springs. Then the tributaries of the Sacramento roll down in deep gorges. On the eastern side, and on to the south for five hundred miles, stretches the great Sierra Nevada, with towering, irregular, and clumsy mountains on its eastern margin, cold, gray, and desolate. It is a region of gorges and peaks, but at their feet there are many beautiful lakes with clear emerald waters. Below the peaks is a region of forest. The traveler, in descending westward to the valley, passes from a zone where forests are low and gnarled by storms, until gradually the trees become more stately, and he reaches the groves of sequoias, — the great trees of the world, whose mighty forms record the history of many centuries of winters and summers. In the valley below, live-oaks are found with branches akimbo, and knotted fists ready for pugilistic fray.

Beyond the valley are the Coast Ranges, where the balm of the tropics bathes the winter with verdure, and boreal zones boon the summer with zephyrs.

THE ROCKY MOUNTAINS.—In an important sense all the mountains west of the Great Plateaus constitute a single group, though the regions into which they are divided are plainly demarcated. There is great diversity, and all known types are found; and there are large areas of plateaus and still larger areas of valleys; yet for some purposes it is convenient to use a general term for them all. For this purpose two names have been used,—"Rocky Mountains" and "Cordilleras." The term "Rocky Mountains" has sometimes been applied to the entire group of groups, both by writers and in popular speech. It has oftener been applied in a vague way to the Stony Mountains, the Park Mountains, the Columbia Plateaus, the Colorado Plateaus, and a part of the Basin Ranges, especially the southern district, or Sierra Madre. The term "Cordilleras" has been used by a few writers to cover the same region, but popular usage is confined mainly to the term "Rocky Mountains." This name has been used in this broader sense to cover the entire region by the officers of the general government, and has been woven into the federal laws with this meaning; so that official and popular usage coincide. For many years it has been used with this significance by the present writer.